

INDIANA DEPARTMENT OF TRANSPORTATION  
MATERIALS AND TESTS DIVISION

THE PROPER USE OF THE PROFILOGRAPH AND THE INTERPRETATION OF  
PROFILOGRAMS  
ITM No. 901-01T

**1.0 SCOPE.**

- 1.1** This test method covers the testing with a profilograph to evaluate the final smoothness of portland cement concrete and HMA pavement. Such testing is performed to determine the profile indexes of all 0.1 mi (0.16 km) sections, and the locations of all individual high or low points having a deviation in excess of 0.3 in. (8 mm).
- 1.2** The values stated in either acceptable English or SI metric units are to be regarded separately as standard, as appropriate for a specification with which this ITM is used. Within the text, SI metric units are shown in parenthesis. The values stated in each system may not be exact equivalents; therefore each system shall be used independently of the other, without combining values in any way.
- 1.3** This ITM may involve hazardous materials, operations, and equipment. This ITM does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this ITM to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

**2.0 TERMINOLOGY.**

- 2.1 Profilograph.** An instrument used to measure vertical irregularities of pavement.
- 2.2 Profilogram.** A continuous paper chart which records irregularities of the profile wheel from the reference plane established by the profilograph.
- 2.3 Profile Wheel.** A wheel at the midpoint of the profilograph frame which is mechanically linked to the recorder which plots the profilogram.
- 2.4 Recorder.** An assembly which mechanically records vertical irregularities of the profile wheel onto the profilogram.
- 2.5 Scallop.** Vertical deviations recorded on the profilogram.
- 2.6 Blanking Band.** Opaque band on a plastic scale within which scallops are not included in the profile index.
- 2.7 Profile Index.** Cumulative total of scallops extending beyond the blanking band measured over a distance on the pavement of 0.1 mi (0.16 km).

**3.0 SIGNIFICANCE AND USE.**

- 3.1 There shall be one profilograph test performed in the right wheel path of each lane equaling or not exceeding 12 ft (3.6 m) in width. The profilograph test shall be conducted approximately 3 ft (1 m) from and parallel to the edge of lane in the direction of traffic movement.
- 3.2 There shall be two profilograph tests performed in a lane exceeding 12 ft (3.6 m) in width. The two profilograph tests shall be performed and each shall be conducted approximately 3 ft (1 meter) from and parallel to each edge of the lane's pavement.
- 3.3 The profile index for each lane equaling or not exceeding 12 ft (3.6 m) in width will be evaluated from the one profile for each 0.1 mi (0.16 km) segment. The profile index for a lane exceeding 12 ft (3.6 m) in width will be evaluated and computed as the average of the two profiles over each 0.1 mi (0.16 km) segment. Termini for each 0.1 mi (0.16 km) segment will be determined during the evaluation of the profile.

#### 4.0 APPARATUS.

- 4.1 **Profilograph.** The condition of the profilograph shall be checked periodically. The profilograph shall be inspected at least once each year before the start of construction activity. Repairs and replacement of damaged or worn parts shall be made before the annual certification of the machine. The following checklist will be used for the inspection.

##### 4.1.1 Certification Checklist.

- (a) Check for roundness and excessive wear to the profile wheel. Excessive wear is defined as the horizontal scale on the profilogram being incorrect by more than 2%.
- (b) Check the return spring in the recorder for straightness or signs of overstressing. With the profilograph on a level surface, the spring should have at least 1 1/2 in. (38 mm) extension between the profile wheel in the up and the down positions.
- (c) Check the cable and bead chain in the recorder for kinks and makeshift repairs.
- (d) Check for missing frame alignment pins at each joint. Check for any appreciable movement at the frame joints.
- (e) Check the carriage wheels for less than a 1 in. (25 mm) worn area across each tire.
- (f) Check the steering rods for straightness and all joints for tightness when assembled.
- (g) Check the rear wheels for tracking within 4 in. (100 mm) of the front wheels.
- (h) Check the profile paper for smooth forward and reverse winding and snug fitting over the recording drum.
- (i) Check the recorder pen assembly for proper drag on the guide rod. No adjustment should be necessary.

- (j) The horizontal scale is checked by running the profilograph a known distance, normally 528 ft (0.16 m), and measuring the length of the profilogram. The horizontal scale of the profilogram to the pavement being profilographed is 1:300. Normally, the only adjustment to be made will be the replacement of the profile wheel when it becomes excessively worn.
- (k) The vertical scale on the profilogram is a scale of 1:1. Before checking the vertical scale, the return spring shall be adjusted as in (b) above. A 1/8 in. (3.2 mm) piece of masonite or similar material is then placed under the profile wheel to provide a reference plane. The chart is then turned by hand to mark the paper. By adding strips under the profile wheel at 1/4 in. (6.3 mm), 1/2 in. (12.7 mm), and 3/4 in. (19.0 mm) thickness increments and marking each step on the paper as above, the actual scale may be determined. The pen assembly has a built-in dampening device where it connects to the cable, allowing approximately 0.01 in. (0.25 mm) movement of the cable before the pen moves. Because of this, the pen assembly should always be reset by moving the paper before and after each block is placed under the wheel.

**4.2 Plastic Scale.** The profile index is determined using a plastic scale 1.70 in. (43 mm) wide and 21.12 in. (536 mm) long. The profile index represents a pavement length of 0.1 mi (0.16 km) at a scale of 1:300. Near the center of the scale is the blanking band 0.2 in. (5 mm) wide extending the entire length of 21.12 in. (536 mm). On either side of this band are scribed lines 0.1 in. (2.5 mm) apart, parallel to the blanking band. These lines serve as a convenient scale to measure scallops.

**4.3 Plastic Template.** A plastic template is used for determination of high or low points. The template shall have a line 1 in. (25 mm) long scribed on one face with a small hole or scribe mark at either end, and a slot 0.3 in. (7.5 mm) from the parallel to the scribed line. See Figure 2. The 1 in. (25 mm) line corresponds to a horizontal distance of 25 ft (7.5 m) on the horizontal scale of the profilogram. The plastic template may be obtained from the Materials and Tests Division.

## **5.0 PROCEDURE.**

### **5.1 Profile Index.**

**5.1.1 Profilograph Testing Limits.** Testing with a profilograph will begin or end in accordance with the following:

- (a) All profilograph testing shall begin or end 50 ft (15 m) from each structure or existing pavement joined by new pavement.
- (b) The profilograph testing of sections 0.1 mi (0.16 km) or less containing a structure shall be conducted as if the structure plus 50 ft (15 m) on either side were not there.
- (c) The last 50 ft (15 m) of the day's paving operation shall be included with the profilograph testing of the next day's paving operation.

- (d) The profilogram will be recorded in such a manner so as to produce a continuous record from the beginning to the end of the pavement to be tested with the profilograph.
- (e) The profile index for each 0.1 mi (0.16 km) section of pavement represented on the profilogram shall be calculated separately.
- (f) The profile index for each section of pavement less than 0.1 mi (0.16 km) shall also be calculated separately.

**5.1.2 Method of Counting.** Place the plastic scale over the profile in such a way as to blank out as much of the profile as possible. When this is done, scallops above and below the blanking band will be approximately balanced. See Figure 1.

The profile trace will proceed from the generally horizontal alignment, proceeding around short radius curves, making it impossible to blank out the central portion of the trace without shifting the scale. The profile should be broken into short sections and the blanking band repositioned on each section while counting as shown in the upper part of Figure 2. The sum of the short sections will equal 21.12 in. (536 mm).

Starting at the right end of the scale, measure and cumulatively total the height of all the scallops appearing both above and below the blanking band, measuring each scallop to the nearest 0.05 in. (1 mm). For multiple peaked scallops, only the highest peak is counted. Write this total on the profile sheet near the left end of the scale together with small horizontal and vertical marks to align the scale when moving to the next section. Short portions of the profile line may be visible outside the blanking band due to rocks or dirt on the pavement. Unless the profile line projects vertically 0.3 in. (8 mm) or more above the zero line and extend longitudinally for 2 ft (610 mm) on the pavement, the bump will not be included in the count. See Figure 1 for illustration of these special conditions.

When scallops occurring in the first 0.1 mi (0.16 km) are totaled, slide the scale to the left, aligning the right end of the scale with the small marks previously made, and begin the counting the second 0.1 mi (0.16 km) in the same manner. If the last section counted is not an even 0.1 mi (0.16 km), its length should be scaled to determine its length in miles to the nearest 0.001 mi (1.5 m). From the example shown in Figure 1, the profile index is determined as follows for the 0.1 mi (0.16 km) section shown:

Length	=	0.1 mi (0.16 km)
Total Count	=	13.5 tenths of an in. or 1.35 in. (34 mm)
Profile Index	=	1.35 in. (34 mm)

## **5.2 High or Low Points in Excess of 0.3 in. (8 mm).**

**5.2.1** At each prominent high or low peak on the profile trace, place the template so that the small holes or scribe marks form a chord across the base of the peak or indicated bump. The line on the template need not be horizontal. With a sharp

pencil draw a line using the narrow slot in the template as a guide. Any portion of the trace extending above this line for a high point or below this line for a low point will indicate the approximate length and height of the deviation in excess of 0.3 in. (8 mm).

There may be instances where the distance between easily recognizable high or low points is less than 25 ft (7.5 m) or 1 in. (25 mm) on the profilogram. In such cases a shorted chord length will be used in marking the scribed line on the template tangent to the trace at the high or low points. It is the intent of this requirement that the horizontal distance for measuring the height of bumps be as nearly 25 ft (7.5 m) or 1 in. (25 mm) on the profilogram as possible, but in no case to exceed this value. When the distance between prominent high or low points is greater than 25 ft (7.5 m) or 1 in. (25 mm) on the profilogram, position the ends of the scribed line to intersect the profilogram with the template in a nearly horizontal position. A few examples of the procedure are shown in the lower portion of Figure 2.

## **6.0 REPORT.**

**6.1 Responsibility.** The Engineer will determine the profile index and high or low points from the original profilogram produced by either the Department or Contractor personnel. The Department will either operate the profilograph or closely monitor the profilograph being operated by the Contractor. Both the before grinding and after grinding profilograms will become part of the contract documentation. All computations for bonus incentive will be the responsibility of the Engineer.

**6.2 Corrective Measures for Profile Indexes Outside Specified Tolerances.** If the 0.1 mi (0.16 km) or less section of pavement exceeds the specified profile index, the Contractor shall select the individual areas to be ground. The Engineer will assist in this section at the written request of the Contractor.

The 0.1 mi (0.16 km) or less section of pavement having been ground will be retested with profilograph to determine compliance with specifications.

**6.3 Corrective Measures for High or Low Points in Excess of 0.3 in. (8mm).** The Engineer will verify that each individual high or low point in excess of 0.3 in. (8mm) requires bump grinding. Individual high or low points requiring grinding will be marked on the pavement from known check points on the profilogram.

Individual high or low points in excess of 0.3 in. (8mm) shall be reduced by grinding until such points do not exceed 0.3 in. (8mm) as indicated by additional runs of the profilograph.

Figure 1

English

## EXAMPLE SHOWING METHOD OF DERIVING PROFILE INDEX FROM PROFILOGRAMS

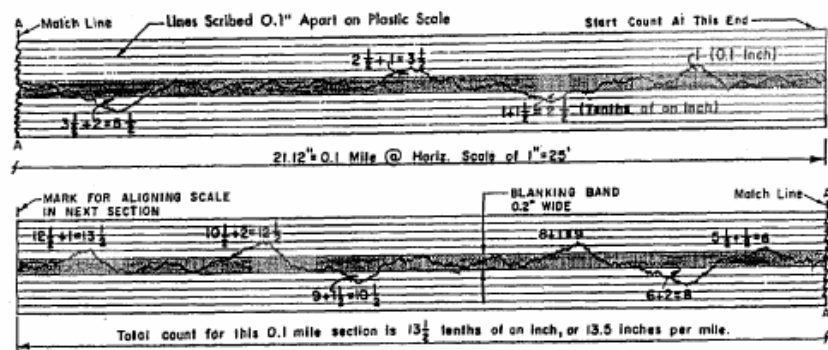


Figure 1

## TYPICAL CONDITIONS

Scallops are areas enclosed by profile line and blanking band. (Shown crosshatched in this sketch)



A

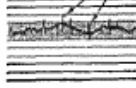
Small projections which are not included in the count.



B

## SPECIAL CONDITIONS

Rock or dirt on the pavement. (Not counted)



C

Double peaked scallop. (Only highest part counted)



D

Figure 2

English

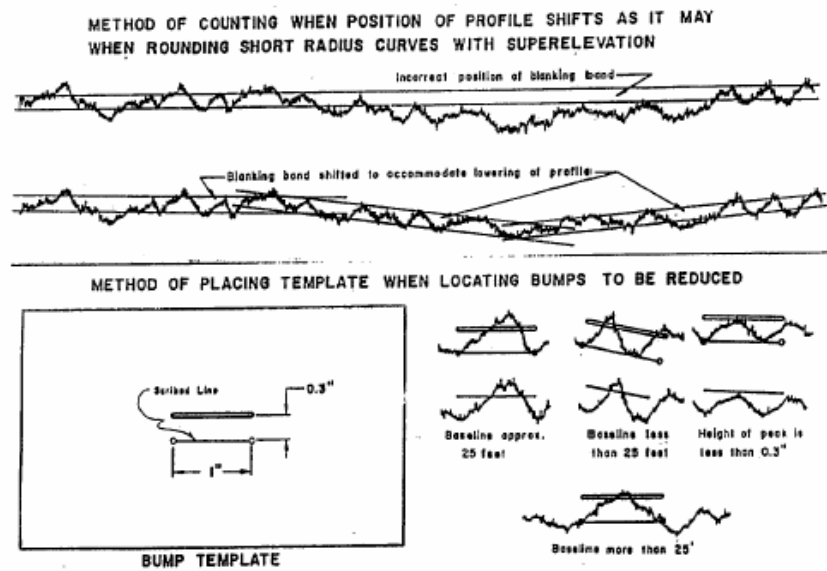


Figure 11